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RECENT PUBLICATIONS IN PHYSICS.

A Physical Treatise on Electricity and Magnetism. By J. E. H. Gordon, B. A., Camb., Assistant Secretary of the British Association. In two volumes. London: 1880. Pp. xviii., 323; xvii., 295. 8vo.

Handbuch der Mechanischen Wärmetheorie. Bearbeitet von Dr. Richard Rühlmann. Zweiter Band. Zweite Lieferung. Braunschweig: 1880.

Catalogue of Books and Papers relating to Electricity, Magnetism, the Electric Telegraph, etc., including the Ronalds Library. Compiled by Sir Francis Ronalds, F. R. S. With a Biographical Memoir. Edited by Alfred J. Frost. London: 1880. Pp. xxvii., 564. 8vo.

Bericht über die wissenschaftlichen Instrumente auf die Berliner Gewerbeausstellung im Jahre 1879. Herausgegeben von Dr. L. Loewenherz, Regierungsrath bei der Kaiserl. Normal-Eichungs-Kommission. Berlin: 1880. Pp. viii., 535. 8vo.

THE advance of physical science, within the past few months, has been not less rapid, and its gains not less substantial, than hitherto; but, with the ever-increasing extent of the field of inquiry, the lines along which scientific investigation has been pushing forward into the region of the unknown have become so numerous that it is quite impossible, in the space of a single article, to summarize even briefly the many important discoveries, or to notice more than a few of the publications which possess a special interest.

Among the more recent scientific publications, Gordon's "Treatise on Electricity and Magnetism" commands notice, as an exposition of the more modern aspects of the subject, and as embodying the most important results of recent investigation. According to the statement of the author, a controlling idea in the construction of the work has been the hypothesis "adopted by Newton, Faraday, and Maxwell," and which now, it may be said, meets with general though not universal acceptance, that there is no such thing as "action at a distance," as it was formerly understood,—that is, action from one point to another without the intervention of any material substance,—but that all electrical actions are transmitted from place to place by strains of some continuous medium filling the intervening space. The word *strain*, it must be understood, has here a somewhat technical use, introduced by Rankine, and means simply alteration of size or shape of the medium, or any portion of it, without including the notion of the force which causes it. It must be observed that Maxwell himself, in his treatise upon electricity, employs the word *stress*, referring constantly to the forces at work, and that Newton and Faraday can hardly be said with propriety to have adopted the idea of strains, which is a modern differentiation, though their notions of the transmission of force through space did substantially involve something like it.

The author's presentation of his subject is principally from the physical side, in the description of actual experiments, with accounts of the apparatus used, and details of its construction and manipulation, excluding mathematical discussions, except such comparative simple computations as are necessary for the calculation of results. The general divisions of the subject are four—namely, Electro-Statics, Magnetism, Electro-Kinetics, and Electro-Optics. Of these, the first, which occupies nearly half of the first volume, embraces, in the earlier chapters, descriptions of the simple and familiar phenomena in which some of the most characteristic effects of electricity are manifested, and of various forms of statical electrical machines. The meaning of quantity, as applied to electricity, the laws and mode of action of electrical force, density, and potential are subjects treated in the following three chapters. Succeeding sections contain descriptions of some of the numerous kinds of electrometers, and discussions of the phenomena of the Leyden jar. A long chapter on specific inductive capacity completes this portion of the work. Considerable prominence is given the experiments of Cavendish in the last century, which were the precursors of the modern methods, and had remained comparatively unnoticed until Maxwell called attention to their great value.

The second part, Magnetism, forms a very brief portion of the volume, and is chiefly devoted to descriptions of the Kew instruments for the determination of terrestrial magnetism. What is given is generally well done, but the range of topics is too limited. As a presentation of such an important subject, it is very inadequate. In some cases, the brevity, or incompleteness, of the statements leads to erroneous impressions, or even to gross inaccuracy. For example, in speaking of the connection between the changes of terrestrial magnetism and sun-spots, the author merely instances the great magnetic storm of 1859, which was coincident with the appearance of one of the largest spots ever observed, though on a previous page, under a different heading, he quotes the discovery of Hofrath Schwabe of the exact agreement of the decennial period of magnetic disturbances with a similar period observable in the recurrence of solar spots. So, of the connection between the aurora and magnetism, it is remarked that the observations at Point Barrow, in 1852–3–4, "the best we yet have, cannot be said to have established any definite law of connection." But what information respecting a period of ten or eleven years could be expected from any series of observations extending over some three years, however carefully made? The results published by Professor Loomis, in 1873, derived from a discussion of observations extending over a period of about one hundred years, do show a most remarkable coincidence between the maxima and minima of auroral frequency, those of the mean daily range of magnetic declination, and those of the relative extent of sun-spots as deduced from Wolf's table of results. A not less decisive conclusion was reached by Professor Balfour Stewart, from the discussion of observations made at Kew. It is contained in an article published by him in "Nature," in 1877. It is true that there has been some controversy as to the precise length of these periods, and their exact equality among themselves, but the fact of a general agreement, both in the time and magnitude of the phenomena, is too well established to be questioned now, and too important to be overlooked. The great mass of the literature of the subject should have been consulted before dismissing a topic of such moment.

The remaining portion of the first volume is occupied with the phenomena produced by the passage of electricity through conducting substances, under the title "Electro-Kinetics." Apparatus, methods and units of measurements of electrical quantities, are discussed in the different chapters, which embody the results of numerous elaborate investigations. The subject is continued in the second volume, of which it forms more than the half. The discharge of electricity in rarefied gases, in the so-called vacuum-tubes, is accorded a space which, important and beautiful as the effects in many cases are, seems disproportionate. The insertion of long extracts from the original memoirs, instead of well-digested summaries, gives to this portion of the work the appearance of having been hastily prepared.

Under the title "Electro-Optics" are grouped the various relations which have been discovered between the action of electricity and certain optical effects. This branch of the subject has for a long time been an attractive one to physicists; but it has recently been very much advanced. A great impulse to the study of it has been given by the suggestive theory of Maxwell, upon the intimate connection between luminous vibrations and the motion of an electrical current. This assumes that the disturbances which result in light and electricity take place in the same ether, and are similar in their nature; from which it would naturally follow that the rate of propagation of electro-static induction should be about the same as the velocity of light, and further, it is concluded that the refractive index of any substance should be equal to the square root of its specific inductive capacity. This affords a test for the theory, and renders it capable of experimental proof or refutation. The few determinations thus far made appear to sustain it, but are not decisive. The author quotes, besides his own experiments, those of Boltzmann, upon crystalline sulphur, those of Schiller, for paraffine and India-rubber, and those of Silow, upon oil of turpentine, which show an approximate verification of Maxwell's law, but still leave much to be desired. No mention is made of Professor E. Root's results, which were obtained by a long and elaborate research in the laboratory of Professor Helmholtz, in Berlin, in which it was shown that, in the case of sulphur and Iceland spar, the relation is so far from being accurately verified as to necessitate the additional assumption of a complete conduction accompanying the dielectric polarization, as in Faraday's theory. Yet, Root's memoir is to be found in the same volume of Poggendorff's "Annalen," with a paper by Silow, quoted by the author.

We have been able to speak of but few of the numerous topics discussed in these handsome volumes. Of the author's method, it may, in general, be said that his enunciations and definitions are carefully expressed and clear, with a commendable freedom from superfluous verbiage. But he is not always thus happy nor always accurate. As has been suggested, some topics appear unduly expanded, for which, if novelty of the facts narrated may be admitted as a reason, it will hardly be judged a sufficient one in a work of this kind. On the other hand, the restricted range of the topics, already mentioned in a particular instance, is a feature of the book as a whole. The expression in the preface, "My object in this treatise has been to give a complete account of such portions of Electrical Science as I am acquainted with," leaves it doubtful whether the author intended to present a complete view of the subject, or whether he has simply followed a natural tendency to give greater prominence to those topics in which he was especially interested, and to those forms of apparatus with which he was most familiar. Unquestionable as is the importance of the former, and the excellence of the latter, it is greatly to be regretted that so many things have been omitted which should find their place in a complete manual. The illustrations are most admirable, both in their execution and with reference to the selection of objects to be represented. They are for the most part new, and the drawings for them have evidently been made with great care. It would be difficult to find a book in which this part of the work has been better done.

In marked contrast with the work just described, both in method and matter, is Rühlmann's "Hand-Book of the Mechanical Theory of Heat," of which a second part of the second volume has recently been issued. The first portion of the work, which was published in 1873, contained a translation of Verdet's two lectures given before the Chemical Society of Paris, in 1862, and the same author's work on the mechanical theory of heat was made the foundation of this book. But the additions made necessary by more recent developments of the science have given to the later portions the character of a new and original work. The part last issued continues the discussion of Thermo-Chemistry, including the relation between heat and work in chemical reactions, so ably investigated by Thomsen, Berthelot, and others; chemical dissociation produced by heat, the thermal phenomena of explosive bodies, and the theory of gas-engines. The development of heat by electricity occupies the remainder of the issue. It has been the aim of the author to give the subject a thorough treatment and systematical mathematical development, and the work bears evidence of great research and careful collation of the experimental results obtained by the numerous investigators who have worked at these important problems.

A valuable and interesting addition to the bibliography of electrical science is the Ronalds Catalogue, recently issued by the Society of Telegraph Engineers of London. It forms a thick octavo volume of nearly six hundred pages, which, for convenient insertion of additional titles, are printed upon one side only, with a short preface, and a biographical memoir of the author, Sir Francis Ronalds, who in 1870 received the honors of knighthood as a tardy recognition of his "early and remarkable labors in telegraphic investigations," and who died in 1873 at the age of eighty-three years. The memoir is of peculiar interest in giving an account of the life and achievements of a man whose retiring disposition and sensitive nature prevented him from winning, in any adequate degree, the recognition which his inventive sagacity, mechanical skill, and scientific ability entitled him to receive. He is indeed now well known in connection with the history of the telegraph, as an inventor so far in advance of his time, that his ideas, although demonstrated by actual experiment to be practicable, and embodying a principle which has been realized in several forms of modern telegraphic apparatus, were wholly unappreciated. As early as 1816 he had actually worked a telegraphic line eight miles in length by means of statical electricity, and proved the practicability of rapidly conveying intelligence to a distance by this means. At that time a semaphore line was in use by the Admiralty for conveying dispatches from London to Portsmouth, the principal naval station of England, and was maintained at a cost of two thousand pounds sterling per annum. Ronalds proposed to Lord Melville, then First Lord of the Admiralty, to exhibit the advantages of his own invention as a substitute, and requested an interview. The departure of Lord Melville from town for some weeks prevented this, and very shortly afterward the inventor received from the Secretary of the Admiralty, afterward Sir John Barrow, the famous communication, which will always hold a place in the history of electrical science as a choice illustration of official conservatism, to the effect "that telegraphs of any kind are now wholly unnecessary; and that no other than the one now in use will be adopted." Ronalds took his disappointment very philosophically, but was apparently discouraged from further efforts to introduce his invention, contenting himself with publishing an account of it in a little book, now become rare, and not even caring to protect his interests by a patent.

On the establishment of the Kew Observatory in 1842, Ronalds was made its first Honorary Director and Superintendent, a position which he occupied for nine years. During this time his inventive genius found full scope, and he made important contributions to electrical and magnetical science in devising instruments and methods of observation, among which was the application of photography to render the instruments self-recording—this alone, as his biographer well remarks, being "sufficient to render his name famous." The catalogue, of which mention has been made, had been in progress for some years, and after his retirement from the position at Kew this, with the collection of the library, was the principal occupation of the remainder of his life. In this work a residence abroad, especially in Italy, gave him excellent facilities for amassing many rarities, and for extending his acquaintance with the literature of electrical science. The library became in time a large and very valuable collection of electrical works, containing many books and memoirs not now easily accessible elsewhere. An especial feature of it is the possession of many works which had once been the personal property of men whose names are eminent in electrical science. The library is supposed to have been originally intended by its owner for the Royal Society, of which he was a Fellow, but it ultimately came into the possession of the Society of Telegraph Engineers, under certain conditions, of which the publication of this catalogue was one. The work appears to have been carefully edited by Mr. Frost, and will be very valuable to students of electricity as a book of reference, especially to such as can have access to the collection itself. It in a measure supplements, so far as its special subject is concerned, the magnificent index to scientific memoirs issued by the Royal Society, which is limited to papers published in scientific journals and the transactions of learned societies. Besides the ordinary bibliographical matter of the various entries, the author has in many instances added some brief particulars respecting the writers, as the place of residence, time of birth and death, official or professional position, and the like. By the terms of his will it was required that it should be published without alteration, so that it is not brought up to the date of publication—a defect which the Society propose to remedy by issuing a supplement, for which they have a large amount of material in hand.

A very interesting and instructive report upon the scientific instruments displayed at the Industrial Exhibition held at Berlin, in 1879, has been published by Dr. L. Loewenherz, assisted by a number of German scientists of high eminence, who have taken an evident and commendable pride in exhibiting to the world the great progress which has been made by their countrymen in the construction of instruments of precision for scientific observations. The report forms a volume of over five hundred pages, profusely illustrated with excellent cuts. We have not the space to particularize the contents of the book, which will commend themselves to every one interested in physical instruments of research. A noticeable feature shown in many of the new forms of apparatus is the adoption of devices for combining increased range of use with convenience of manipulation and great precision in the readings. In some cases a tendency toward too great complexity of parts is apparent, as in the kathetometer figured upon page 182, which, judging from the description, has been so overloaded with heavy accessories as to develop a flexure of the main support, sufficient to seriously impair the value of measurements made with it.

A few months since, Professor C. A. Young announced the curious fact that, when the quantity and temperature of sodium vapor present in the flame of a Bunsen lamp are greatly increased, the spectrum of the light exhibits two bright lines in place of each of the components of the double line ordinarily seen. This peculiar modification of the spectrum has recently been observed by him on several occasions at the base of solar prominences, the double reversal occurring in the lines belonging to sodium, and in some of those belonging to magnesium. This interesting observation is described in a communication published in the "American Journal of Science" for November last. The same article contains an account of an arrangement in which, by the use of a diffraction grating of unusually fine quality, a spectroscope was constructed giving an enormous dispersion with very excellent definition of the spectral lines. The author has applied this instrument to the study of the lines, seventy in number, which in Ångström's map are represented as common to two or more substances, with the result that fifty-six of them have been distinctly seen to be double or triple, seven are doubtful, and only the remaining seven appear to be single. The question whether or not the components of these complex lines are still common to the spectra of different metals must be settled by further research, but it will have an important bearing upon theories recently advanced, in which an argument for the derivation of different chemical elements from some common substance is drawn from the assumed identity of lines observed in their spectra.

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